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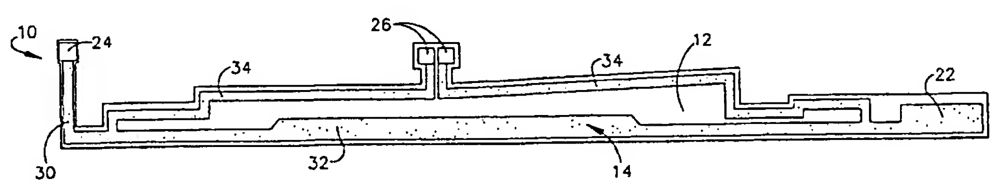
(54) Title: MULTI-FEED ANTENNA SYTEM



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(57) Abstract: An antenna system for a portable communication device comprises an antenna structure for transmitting and receiving signals. The antenna structure includes multiple feeding ports and multiple antennas of different types having a common structure fully coupling the multiple antennas together. This antenna structure is made of a conductor that can be surface mounted over a nonplanar surface. When the conductor is mounted on a nonplanar surface, the antenna structure may extend in three dimensional space around the portable communications device.

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 031 505 A (QI YIHONG ET AL) 29 February 2000 (2000-02-29) the whole document ---	1,2,6-9, 11-15, 19-26, 28-32, 34-39,41
X	EP 0 892 459 A (NOKIA MOBILE PHONES LTD) 20 January 1999 (1999-01-20) abstract ---	1,8-15, 21-23, 26-32, 36-42
X	EP 0 765 001 A (MURATA MANUFACTURING CO) 26 March 1997 (1997-03-26) the whole document --- -/--	1,8-14, 22,23, 26-30

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 990 838 A (WOO CHONG L ET AL) 23 November 1999 (1999-11-23) abstract -----	1-43

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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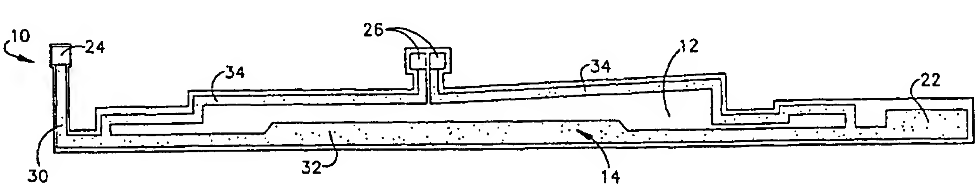
(54) Title: ELECTRICALLY CONNECTED MULTI-FEED ANTENNA SYSTEM



(57) Abstract: An antenna system for a portable communication device comprises an antenna structure for transmitting and receiving signals. The antenna structure includes multiple feeding ports and multiple antennas of different types having a common structure fully coupling the multiple antennas together. This antenna structure is made of a conductor that can be surface mounted over a nonplanar surface. When the conductor is mounted on a nonplanar surface, the antenna structure may extend in three dimensional space around the portable communications device.

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ELECTRICALLY CONNECTED MULTI-FEED ANTENNA SYSTEM

Field of the Invention

The present invention relates to antennas that can send and receive signals from radio frequency (RF) communication devices. In particular the present invention relates to antennas that are used in portable hand held communication devices.

Background of the Invention

An antenna is a transforming element that converts circuit currents into electromagnetic energy. Conversely, an antenna can also convert electromagnetic energy into circuit currents. The frequency to which an antenna responds is based on physical characteristics of the antenna such as width and length. Changes in the width and length of the antenna affect the resistance of the antenna and shape the current densities along the length of the antenna. The antenna field can be affected by nearby objects, such as other antennas, which distort the performance of the antenna.

In order to provide for operation of a communication device at different frequencies, previous designs have included multiple distinct antennas, one for each desired operating frequency. Due to interference between the antennas and the resultant inefficiencies however, multiple antenna arrangements may not be feasible in many applications, particularly in mobile communication devices with limited power supplies.

An alternative to such multiple antenna arrangements is a multiple feed antenna. Known multiple feed antennas provide different antenna feeding ports on the

same type of antenna. Although the multiple ports allow for different antenna element lengths and thus different frequencies of operation, since the ports are directly connected to the same antenna, each port causes signal losses and other interference effects on antenna currents. For example, a transmission signal applied to the antenna by one feeding port will partially leak back through the antenna to the other feeding port instead of being converted into electromagnetic energy by the antenna, thereby reducing the efficiency of the antenna. Another major shortcoming of such designs is the coupling between antenna elements. The antenna type "seen" from both feeding points is the same, a monopole antenna in many conventional designs, resulting a very tight coupling between the antenna elements. This tight coupling may cause serious problems when the antenna system is implemented in a complicated environment. For example, changing the match for one of the feeding points is likely affect the match of the other one.

Thus, there remains a need for a portable hand-held communications device that efficiently implements an antenna in at least a transmitting or a receiving configuration. There remains a further need for such an antenna system where there is some degree of isolation between the transmitting and receiving structures. The antenna preferably conforms to the housing of the device and is positioned so that the antenna will transmit and receive regardless of the orientation of the device relative to a communications station.

Summary of the Invention

An antenna system for a portable transceiver device comprises an antenna structure for transmitting and receiving RF signals. The antenna structure includes multiple feeding ports having a common structure fully coupling multiple antennas of different types to each other. This antenna structure is made of a conductor that may be surface mounted over a nonplanar surface, but may also be implemented as a free-standing element. When the conductor is mounted on a nonplanar surface, the antenna structure preferably extends in three-dimensional space around a portable hand held communications device.

According to an embodiment of the invention, an antenna system comprises an antenna structure, a first feeding port, and a second feeding port. The first and second feeding ports connect the antenna structure to communications circuitry. The antenna structure forms a first antenna structure of a first antenna type connected to the first feeding port and further forms a second antenna structure of a second antenna type connected to the second feeding port. Importantly, a portion of the first antenna structure is also a portion of the second antenna structure.

In a further embodiment of the present invention, there is also provided a portable communications device comprising: a transmitting circuit; a receiving circuit; and an antenna system, wherein the antenna system comprising a first antenna structure of a first antenna type and a second antenna structure of a second antenna type has a common portion of a radiation element fully coupling the first antenna structure to the second antenna structure. Preferably, the first antenna structure and the second antenna structure include a monopole antenna, a dipole antenna, and a top

loaded member wherein the top loaded member is a portion of the first antenna structure and the second antenna structure. Preferred applications of the present invention include portable communication devices, wireless personal digital assistants (PDAs), two-way paging devices and cellular telephones.

Some of the advantages provided by the present invention include: high efficiency, high gain, wide bandwidth, and low SAR. Furthermore, the use of two feeding points allows optimization of a communication module circuit board layout to minimize electromagnetic interference (EMI) problems. Since the antenna structures are electrically coupled, there are no performance issues regarding electromagnetic coupling between antennas in the present invention as in traditional separate two-antenna solutions wherein the electromagnetic coupling between the antennas degrades the antenna performance.

Another advantage of the present invention is the simple layout, which simplifies fabrication and thus provides for lower manufacturing costs. In addition, the present invention allows for the use of one piece of wire to realize two different antenna functions. A folded dipole used as a transmitting antenna in accordance with an aspect of the invention raises the antenna radiation resistance and thereby increases radiation efficiency.

Traditional dipoles and monopoles that are widely used in wireless devices are very sensitive to a change in the environment. In contrast, the present invention is less sensitive to the environment. This can be accomplished according to an aspect of the invention by introducing a balanced structure such as a dipole instead of using two

unbalanced structures such as monopoles for example. The balanced structure will be more immune from its the operating environment.

Brief Description of the Drawings

Further advantages and features of the invention will become apparent from the following description, in which:

Fig. 1 is a top view of an antenna system comprising a preferred embodiment of the invention;

Fig. 2 is an orthogonal view of the antenna system of Fig. 1 mounted on a telecommunications device housing;

Fig. 3 is a partial view of the antenna system of Fig. 1;

Fig. 4 also is a partial view of the antenna system of Fig. 1; and

Fig. 5 is a block diagram of a communication device in which an antenna system according to the invention may be implemented.

Description of a Preferred Embodiment

An antenna system 10 comprising a preferred embodiment of the present invention is shown in Figure 1. The antenna system 10 comprises at least an antenna structure 14, which may be affixed to a backing element 12. The backing element 12 is preferably made of a thin, flexible material which merely provides additional physical support for the antenna structure 14. Preferably, the antenna structure 14 is made of a low resistance conductor and affixed to the backing element 12. In this

manner, the antenna system 10 may be a laminate with layers of the antenna structure 14 and the backing element 12.

The laminate arrangement shown in Fig. 1 provides increased structural integrity of the antenna system 10. The backing element 12 performs no operational functions and the antenna structure 14 is fully operational without the backing element 12. Where the antenna system 14 is to be mounted on a further structural element and fabricated at the same time as the further element, the antenna structure may be mounted directly on the further structural element such that the backing element 12 is not necessary. If the antenna is separately fabricated and is to be added to a device after or during its manufacture however, the backing element is preferred in order to provide for handling of the antenna structure 14 while reducing the likelihood of damage thereto during such handling.

The antenna structure 14 has distinct portions defining a radiating element, a top loading member 22, a monopole feeding port 24, and a dipole feeding port 26. The radiating element is a conductor that extends from the feeding ports 24 and 26 to the top loading member 22. Portions of the radiating element include: a monopole portion 30, a common portion 32, and a dipole portion 34. These portions 30-34 are configured so that the radiating member includes a first antenna structure 40 (as shown in Fig 3) that functions as an effective monopole antenna and a second antenna structure 44 (as shown in Fig 4) that functions as an effective dipole antenna.

When the antenna system 10 is excited from the monopole feeding port 24, the dipole feeding port 26 and the dipole portion 34 of the antenna structure 14 are a load on the effective monopole antenna 40 (indicated as XX and YY on Fig. 3). When the

system is excited from the dipole feeding port 26, the monopole feeding port 24 and the monopole portion 30 of the antenna structure 14 are a load on the effective dipole antenna 44 (indicated as ZZ on Fig. 4).

The effective monopole antenna 40 includes a current path along the radiating element between the monopole feeding port 24 and the top loading member 22. As shown in Fig. 3, the primary path of the effective monopole antenna 40 is defined by the monopole portion 30, the common portion 32 and the top loading member 22. The loads XX and YY between the monopole feeding port 24 and the top loading member 22 have a high impedance due to the characteristic high input impedance of the dipole antenna 44, and consequently, very small amounts of current are delivered through the loads. The effective dipole antenna 44 includes a current path along the radiating element between the dipole feeding port 26 and the top loading member 22. As shown in Fig. 4, the path of the effective dipole antenna 44 comprises the dipole portion 30, the common portion 32, and the top loading portion 36. The load ZZ between the dipole feeding port 26 and the top loading member 22 has a high impedance, and consequently, a very small amount of current is delivered through the load.

Figure 2 shows a contemplated implementation of an antenna system according to the above embodiment of the invention. A dielectric housing 46 is a box-shaped container made of a dielectric material. The dielectric housing 46 has a top and bottom surface 52 and 54, a front and back surface 56 and 58, and opposite side surfaces 60 and 62. Within the dielectric housing 46 is a transmitting circuit 70 and a receiving circuit 74. The dielectric housing 46 holds the electronics of the transmitting circuit 70 and the receiving circuit 74.

The antenna system 10 is folded from the original, flat configuration of Fig. 1 to the configuration in which it is mounted on the inside of the dielectric housing 46, as shown in Fig. 2. The antenna system 10 then extends around the dielectric housing 46 to orient the antenna structure 14 in multiple perpendicular planes. The top loading member 22 and the common portion 32 of the radiating element are mounted on the side surface 60. The common portion 32 and the dipole portion 34 of the radiating element extend around a front corner 78 from the side surface 60 to the front surface 56. The common portion 32 extends fully along the front surface 56 to the opposite corner 80. The dipole portion 34 turns upward from the front surface 56 to the top surface 52 and extends along the top surface 52. The dipole feeding port 26 also is located on the top surface 52 of the dielectric housing 46. Near the corner 80, the dipole portion 34 turns down from the top surface 52 back onto the front surface 56. The monopole portion 30 turns around the far front corner 80 from the front surface 56 to the far side surface 62 and again turns from the side surface 62 upward onto the top surface 52. The effective monopole antenna 40 and the effective dipole antenna 44 each extend in a plane parallel to the front surface 56, and planes parallel to the top surface 52, and the side surface 60. This orientation of the antenna system 10 makes the portable communications device 56 an omnidirectional transmit and receive device.

The monopole feeding port 24 is connected to the receiving circuit 74. The dipole feeding port 26 is connected to the transmitting circuit 70. Importantly, the current distributed from the monopole feeding port 24 mainly flows along the effective monopole antenna 40 while only a small amount of current travels along the

loads XX and YY. Since these loads are the high impedances of the dipole portion 34, dipole feeding port 26 and transmitting circuitry 70, the current distribution along the effective monopole antenna 40 is minimally changed. Similarly, when current is distributed from the dipole feed port 26, the current mainly flows along the effective dipole antenna 44 while a small amount of current travels along the load ZZ. Since the load ZZ is the high impedance of the monopole portion 30, monopole feeding port 24 and receiving circuit 74, the current distribution along the effective dipole antenna 44 is minimally changed. This configuration is important in the operation of the antenna system 10 in its transmit and receive states.

The effective monopole antenna 40 is sized to receive signals from a radio wave at a particular frequency by defining the length and width of its radiating element appropriately. Since the loads XX and YY have a high impedance, most of the current generated along the antenna structure 14 from the received radio signal is distributed along the effective monopole antenna 40. The length of the common portion 32 of the radiating element is sized so that the antenna is tuned to the chosen frequency for receiving signals.

The effective dipole antenna 44 is sized to transmit a signal at a specified frequency by defining the length and width of its radiating element appropriately. The high impedance of the load ZZ of the antenna structure 14 forces the current from the transmitting circuit 70 to flow along the effective dipole antenna 44. The length of the effective dipole antenna 44 is the length of both the common portion 32 and the dipole portion 34. The dipole portion 34 can thus be sized with the prior knowledge of

the length of the common portion 32 to convert the circuit currents of the transmitting antenna to an electromagnetic signal at the desired frequency.

The top loading member 22 of the antenna structure 14 further alters the current distribution of each effective antenna 40 and 44. The top loading member thus further shapes the characteristics of each effective antenna 40 and 44 by adding perceived length to the antenna structure 14.

Fig. 5 is a block diagram of a mobile communication device 100 in which the instant invention may be implemented. The mobile communication device 100 is preferably a two-way communication device having at least voice and data communication capabilities. The device preferably has the capability to communicate with other computer systems on the Internet. Depending on the functionality provided by the device, the device may be referred to as a data messaging device, a two-way pager, a cellular telephone with data messaging capabilities, a wireless Internet appliance or a data communication device (with or without telephony capabilities).

Where the device 100 is enabled for two-way communications, the device will incorporate a communication subsystem 110, including a transmitter 70 and a receiver 74, as also shown in Fig. 2, an antenna system 10 incorporating antenna elements 40 and 44, local oscillators (LOs) 112, and a processing module such as a digital signal processor (DSP) 114. Although separate antenna elements 40 and 44 are shown in Fig. 5, it is to be understood that such antenna elements are electrically connected as described above to form an antenna system according to the invention. In the embodiment shown in Fig. 2 for example, the antenna 10 could be mounted directly on a dielectric housing which encloses components of the communication device 100.

As will be apparent to those skilled in the field of communications, the particular design of the communication subsystem 110 will be dependent upon the communication network in which the device is intended to operate. For example, a device 100 destined for a North American market may include a communication subsystem 110 designed to operate within the Mobitex^{TM} mobile communication system or DataTAC^{TM} mobile communication system, whereas a device 101 intended for use in Europe may incorporate a General Packet Radio Service (GPRS) communication subsystem 110.

Network access requirements will also vary depending upon the type of network 116. For example, in the Mobitex and DataTAC networks, mobile devices such as 100 are registered on the network using a unique personal identification number or PIN associated with each device. In GPRS networks however, network access is associated with a subscriber or user of a device 100. A GPRS device therefore requires a subscriber identity module (not shown), commonly referred to as a SIM card, in order to operate on a GPRS network. Without a SIM card, a GPRS device will not be fully functional. Local or non-network communication functions (if any) may be operable, but the device 100 will be unable to carry out any functions involving communications over network 116. When required network registration or activation procedures have been completed, a device 100 may send and receive communication signals over the network 116.

Signals received by the antenna element 40 through a communication network 116 are input to the receiver 74, which may perform such common receiver functions as signal amplification, frequency down conversion, filtering, channel selection and

the like, and in the example system shown in Fig. 5, analog to digital conversion. Analog to digital conversion of a received signal allows more complex communication functions such as demodulation and decoding to be performed in the DSP 114. In a similar manner, signals to be transmitted are processed, including modulation and encoding for example, by the DSP 114 and input to the transmitter 70 for digital to analog conversion, frequency up conversion, filtering, amplification and transmission over the communication network 116 via the antenna element 44.

The DSP 114 not only processes communication signals, but also provides for receiver and transmitter control. For example, the gains applied to communication signals in the receiver 74 and transmitter 70 may be adaptively controlled through automatic gain control algorithms implemented in the DSP 114.

The device 100 preferably includes a microprocessor 118 which controls the overall operation of the device. Communication functions, including at least data and voice communications, are performed through the communication subsystem 110. The microprocessor 118 also interacts with further device subsystems such as the display 120, flash memory 122, random access memory (RAM) 124, auxiliary input/output (I/O) subsystems 126, serial port 128, keyboard 130, speaker 132, microphone 134, a short-range communications subsystem 136 and any other device subsystems generally designated as 138.

Some of the subsystems shown in Fig. 5 perform communication-related functions, whereas other subsystems may provide "resident" or on-device functions. Notably, some subsystems, such as keyboard 130 and display 120 for example, may be used for both communication-related functions, such as entering a text message for

transmission over a communication network, and device-resident functions such as a calculator or task list.

Operating system software used by the microprocessor 118 is preferably stored in a persistent store such as flash memory 122, which may instead be a read only memory (ROM) or similar storage element (not shown). Those skilled in the art will appreciate that the operating system, specific device applications, or parts thereof, may be temporarily loaded into a volatile store such as RAM 124. It is contemplated that received communication signals may also be stored to RAM 124.

The microprocessor 118, in addition to its operating system functions, preferably enables execution of software applications on the device. A predetermined set of applications which control basic device operations, including at least data and voice communication applications for example, will normally be installed on the device 100 during manufacture. Further applications may also be loaded onto the device 100 through the network 116, an auxiliary I/O subsystem 126, serial port 128, short-range communications subsystem 136 or any other suitable subsystem 138, and installed by a user in the RAM 124 or preferably a non-volatile store (not shown) for execution by the microprocessor 118. Such flexibility in application installation increases the functionality of the device and may provide enhanced on-device functions, communication-related functions, or both. For example, secure communication applications may enable electronic commerce functions and other such financial transactions to be performed using the device 100.

In a data communication mode, a received signal such as a text message or web page download will be processed by the communication subsystem 110 and input

to the microprocessor 118, which will preferably further process the received signal for output to the display 120, or alternatively to an auxiliary I/O device 126. A user of device 100 may also compose data items such as email messages for example, using the keyboard 130, which is preferably a complete alphanumeric keyboard or telephone-type keypad, in conjunction with the display 120 and possibly an auxiliary I/O device 126. Such composed items may then be transmitted over a communication network through the communication subsystem 110.

For voice communications, overall operation of the device 100 is substantially similar, except that received signals would preferably be output to a speaker 132 and signals for transmission would be generated by a microphone 134. Alternative voice or audio I/O subsystems such as a voice message recording subsystem may also be implemented on the device 100. Although voice or audio signal output is preferably accomplished primarily through the speaker 132, the display 120 may also be used to provide an indication of the identity of a calling party, the duration of a voice call, or other voice call related information for example.

The serial port 128 in Fig. 1 would normally be implemented in a personal digital assistant (PDA)-type communication device for which synchronization with a user's desktop computer (not shown) may be desirable, but is an optional device component. Such a port 128 would enable a user to set preferences through an external device or software application and would extend the capabilities of the device by providing for information or software downloads to the device 100 other than through a wireless communication network. The alternate download path may for

example be used to load an encryption key onto the device through a direct and thus reliable and trusted connection to thereby enable secure device communication.

A short-range communications subsystem 138 is a further optional component which may provide for communication between the device 100 and different systems or devices, which need not necessarily be similar devices. For example, the subsystem 138 may include an infrared device and associated circuits and components or a Bluetooth™ communication module to provide for communication with similarly-enabled systems and devices.

The invention has been described with reference to a preferred embodiment. Those skilled in the art will perceive improvements, changes, and modifications. Such improvements, changes, and modifications are intended to be within the scope of the claims.

For example, other types of antennas will be apparent to those skilled in the art. The invention is in no way limited to a multi-feed antenna having a monopole antenna structure and a dipole antenna structure. Other types of antenna structures sharing a common antenna portion are also contemplated. Further types and designs of communication devices other than the device shown in Fig. 5 will also be apparent.

The following is claimed:

1. An antenna system comprising:

an antenna structure;

a first feeding port configured to connect the antenna structure to communications circuitry; and

a second feeding port configured to connect the antenna structure to communications circuitry;

the antenna structure forming a first antenna structure of a first antenna type connected to the first feeding port, and further forming a second antenna structure of a second antenna type connected to the second feeding port with a portion of the first antenna structure also being a portion of the second antenna structure.

2. An antenna system as defined in claim 1 wherein the first antenna structure and the second antenna structure include a monopole antenna.

3. An antenna system as defined in claim 1 wherein the first antenna structure and the second antenna structure include a dipole antenna.

4. An antenna system as defined in claim 1 wherein the first antenna structure and the second antenna structure include an unbalanced antenna.

5. An antenna system as defined in claim 1 wherein the first antenna structure and the second antenna structure include a balanced antenna.

6. An antenna system as defined in claim 1 wherein the first antenna structure and the

second antenna structure comprise a top loaded member.

7. An antenna system as defined in claim 6 wherein the top loaded member is a portion of the first antenna structure and the second antenna structure.

8. An antenna system as defined in claim 1 wherein the antenna system is operable in a portable communication device.

9. An antenna system as defined in claim 8 wherein the portable communication device is a data communication device.

10. An antenna system as defined in claim 8 wherein the portable communication device provides data and voice communications functions.

11. An antenna system as defined in claim 1 wherein the antenna system is operable in a

wireless PDA.

12. An antenna system as defined in claim 1 wherein the antenna system is operable in a

wireless paging device.

13. An antenna system as defined in claim 1 wherein the antenna system is operable in a

wireless two-way paging device.

14. An antenna system comprising:

a first antenna structure of a first antenna type having a first radiation element; and

a second antenna structure of a second antenna type;

the first antenna structure and the second antenna structure being electrically connected through a portion of the first radiation element such that the second antenna structure includes the portion of the first radiation element to form a second radiation element.

15. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure include a monopole antenna.

16. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure include an unbalanced antenna.

17. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure include a dipole antenna.

18. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure include a balanced antenna.

19. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure comprise a top loaded member.

20. An antenna system as defined in claim 19 wherein the top loaded member is a portion of the first antenna structure and the second antenna structure.

21. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure comprise a transmitting antenna and a receiving antenna.

22. An antenna system as defined in claim 14 further comprising a pair of feeding ports.

23. An antenna system as defined in claim 22 wherein the feeding ports are connected to a radio circuit.

24. An antenna system as defined in claim 14 wherein the first antenna structure and the second antenna structure are mounted on a mounting surface , the mounting surface extending in three dimensions so as to orient the first antenna structure and the second antenna structure in the three dimensions.

25. An antenna system as defined in claim 24 wherein the mounting surface is a dielectric substrate.

26. An antenna system as defined in claim 14 wherein the antenna system is operable in a portable communication device.

27. An antenna system as defined in claim 26 wherein the portable communication device provides voice and data communications functions.

28. An antenna system as defined in claim 14 wherein the antenna system is operable in a wireless PDA.

29. An antenna system as defined in claim 14 wherein the antenna system is operable in a wireless paging device.

30. An antenna system as defined in claim 14 wherein the antenna system is operable in a wireless two-way paging device.

31. A portable communications apparatus comprising:

a transmitting circuit;

a receiving circuit; and

an antenna system;

the antenna system comprising a first antenna structure of a first antenna type and a second antenna structure of a second antenna type which has a common portion of a radiation element fully coupling the first antenna structure to the second antenna structure.

32. An antenna system as defined in claim 31 wherein the first antenna structure and the second antenna structure include a monopole antenna.

33. An antenna system as defined in claim 31 wherein the first antenna structure and the second antenna structure include a dipole antenna.

34. An antenna system as defined in claim 31 wherein the first antenna structure and the second antenna structure comprise a top loaded member.

35. An antenna system as defined in claim 34 wherein the top loaded member is a portion of the first antenna structure and the second antenna structure.

36. An antenna system as defined in claim 31 wherein the antenna system is operable in a portable communication device.

37. An antenna system as defined in claim 31 wherein the antenna system is operable in a wireless PDA.

38. An antenna system as defined in claim 31 wherein the antenna system is operable in a wireless paging device.

39. An antenna system as defined in claim 31 wherein the antenna system is operable in a wireless two-way paging device.

40. An antenna system as defined in claim 36 wherein the portable communication device is a cellular telephone.

41. An antenna system as defined in claim 36 wherein the portable communication device is a data communication device.

42. An antenna system as defined in claim 36 wherein the portable communication device provides a data and voice communication functions.

43. An antenna system as defined in claim 31 wherein the first antenna structure and the second antenna structure include a unbalanced antenna and an balanced antenna.

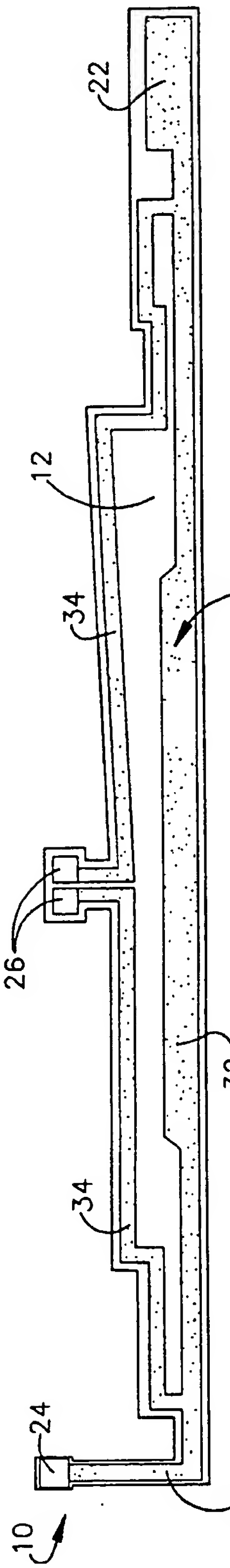
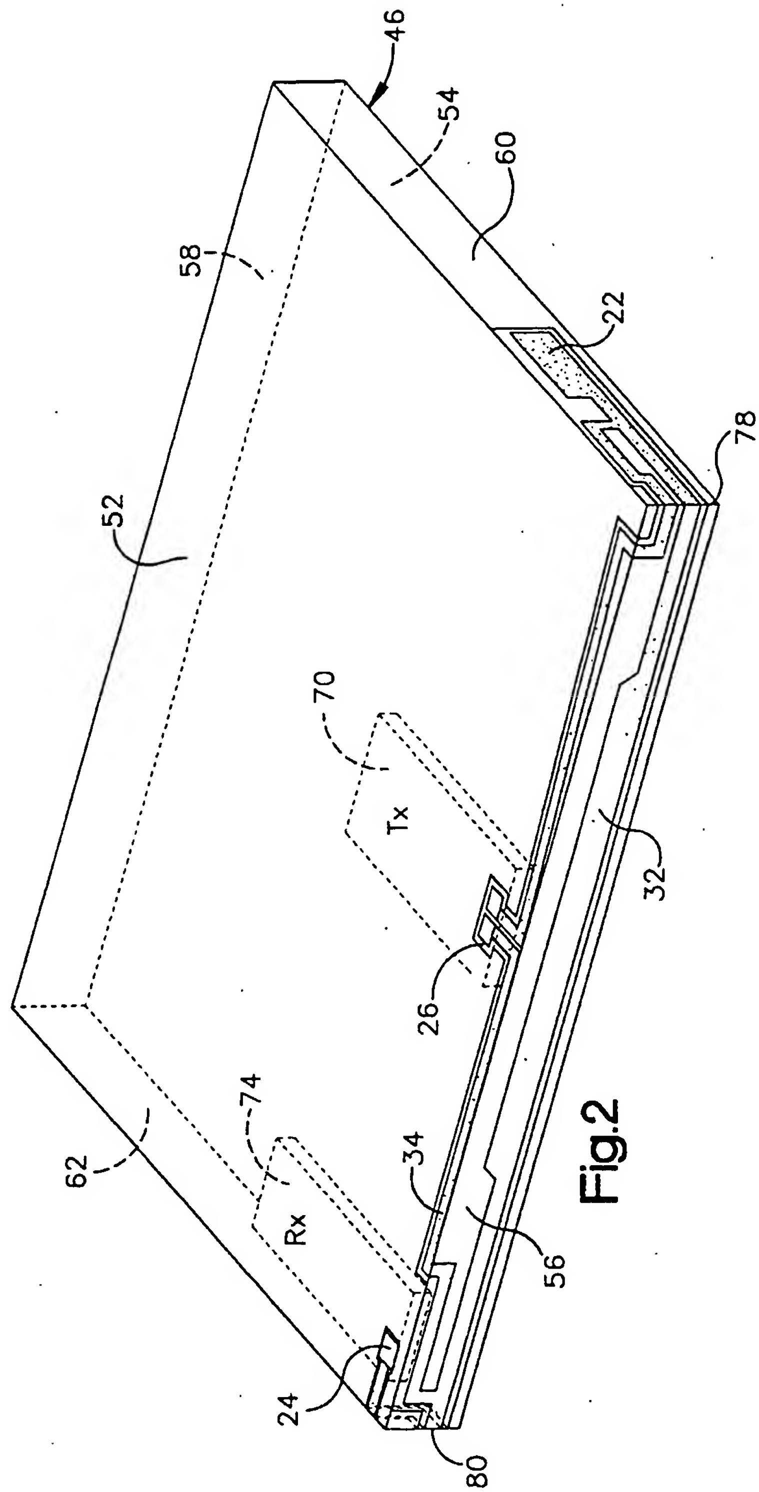

22
12
34
14
26
32
34
24
30
10

Fig.1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Tx
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Rx
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24
80

Fig.2

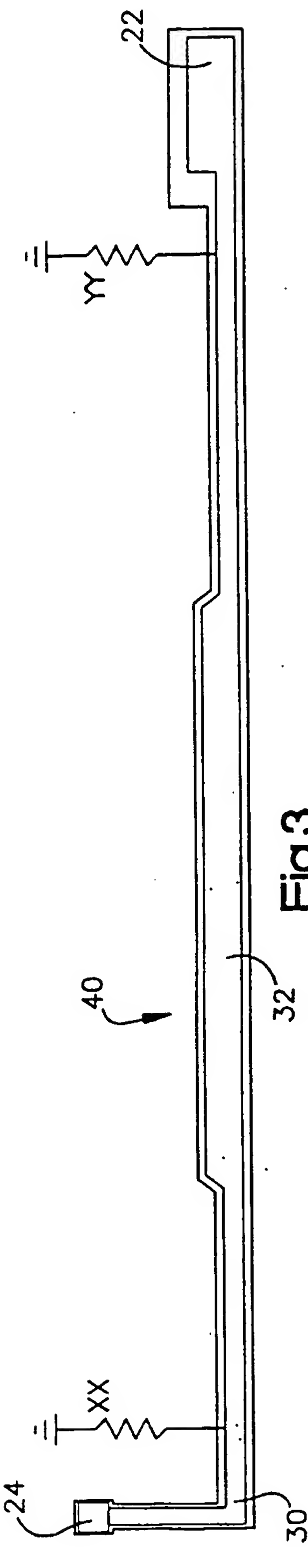

Fig.3

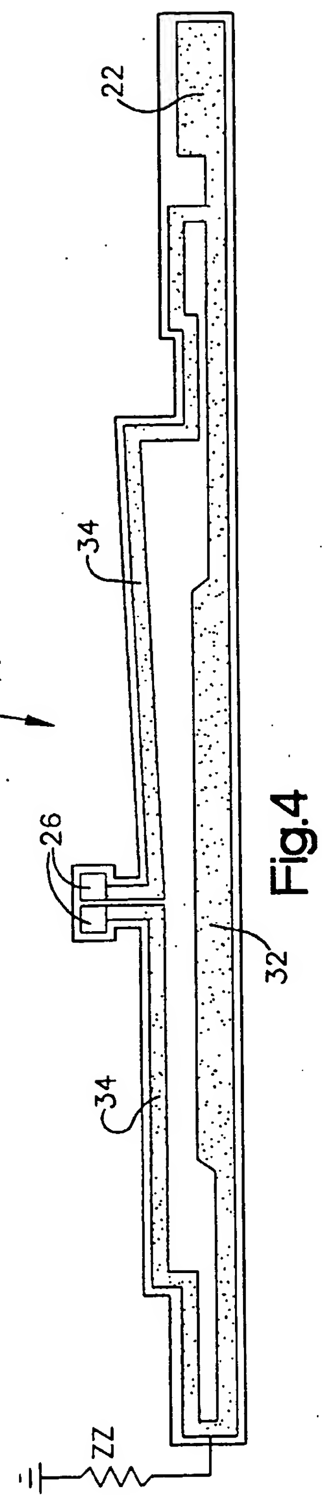

Fig.4

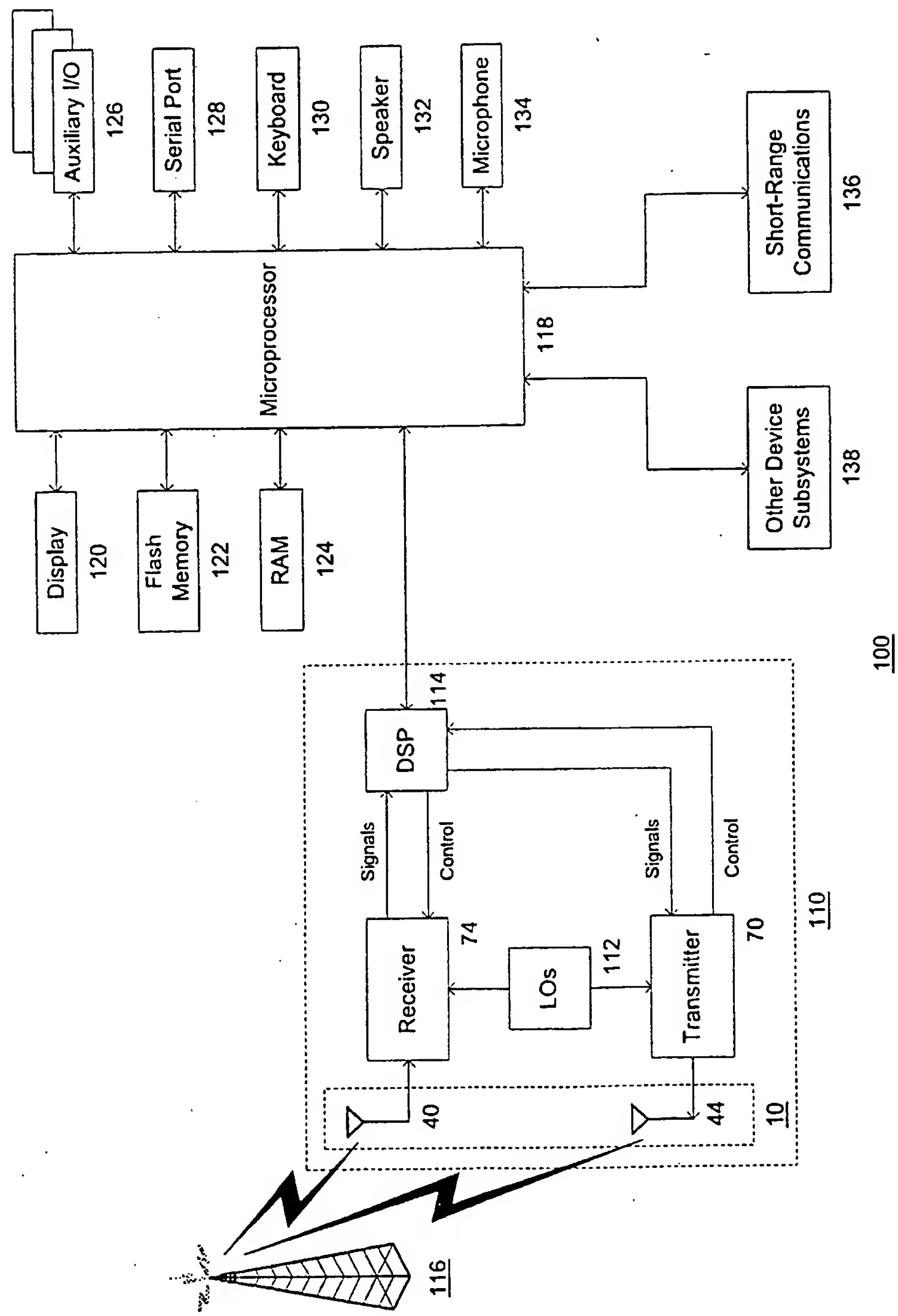
Auxiliary I/O
126
Serial Port
128
Keyboard
130
Speaker
132
Microphone
134
Microprocessor
118
Short-Range Communications
136
Other Device Subsystems
138
Display
120
Flash Memory
122
RAM
124
DSP
114
Signals
Control
Signals
Control
Receiver
74
LOs
112
Transmitter
70
110
40
44
10
116
100

FIG. 5